CERTIFICATION

I, KIYOSHI INAGAKI of FUSOH PATENT FIRM, Rindo-building, 37, Kand-Higashimatsushita-cho, Chiyoda-ku, Tokyo, Japan, hereby certify that I am the translator of the accompanying certified official copy of the patent application No.9-337275 filed in Japan on the 8th day of December, 1997, and certify that the following is a true and correct translation to the best of my knowledge and belief.

Dated this 6th day of September, 2002.

K. Inagaki

Kiyoshi Inagaki

Patent Office
Japanese Government

This is to certify that the annexed is a true copy of the following application as filed in this Office

Date of Application December 8, 1997
Application Number Heisei, 9th,
Patent Application No. 337275
Applicant(s) NEC Corporation

September 4, 1998
Commissioner, Patent Office Kenji ISAYAMA
Certificate Number Patent-Hei-10-3071019

[Document Name] REQUEST FOR PATENT APPLICATION

[Reference Number] 74601976

[Filing Date] December 8, 1997

[Filed to] Commissioner, Patent Office, Hisamitsu Arai

[International Classification] G02F 1/136

[Title of the Invention] ACTIVE MATRIX LIQUID CRYSTAL DISPLAY DEVICE

[Number of Claims] 3

[Inventor]

[Domicile or Residence] c/o NEC Corporation, 7-1, Shiba 5-chome, Minato-ku, Tokyo, Japan

[Name] Hironori KIKKAWA

[Applicant for Patent]

[Discernment Number] 000004237

[Name] NEC Corporation

[Agent]

[Discernment Number] 100095740

[Patent Attorney]

[Name] Muneaki KAIGUCHI

[Designation of Fees]

[Number of Advance Payment Register] 025782

[Amount Paid] 21000

[List of Appended Documents]

[Document Name]	Specification	1
[Document Name]	Drawings	1
[Document Name]	Abstract	1

[General Authorization Number] 9606620

[Proof Requested or not] Requested

[Document Name] Specification

[Title of the Invention] ACTIVE MATRIX LIQUID CRYSTAL DISPLAY DEVICE

[Claims]

[claim 1] An active matrix liquid crystal display device wherein liquid crystal is sandwiched between one and another transparent insulating substrates, said one transparent insulating substrate includes a plurality of scanning lines, signal lines and common electrode lines arranged in a matrix, said scanning lines and said signal lines are driven by a scanning signal driver and a video signal driver, respectively, disposed at a peripheral area, an intersection between said scanning line and said signal line includes a thin film transistor having a gate electrode, a drain electrode, and source electrode connected to said scanning line, said signal line and said pixel electrode, respectively, said one transparent insulating substrate includes a plurality of pixel areas wherein the molecular axis directions of said liquid crystal molecules are rotated by an electric field formed by said pixel electrode and said common electrode line in a plane parallel to said substrate to control transmittance, and said another transparent insulating substrate includes a light shielding layer for shielding at least an area other than said pixel areas, characterized in that:

said common electrode lines are configured to encircle outer periphery of said pixel areas, said pixel electrode overlaps said

common electrode lines in the outer periphery of said pixel, said light shielding layer resides outside said pixel areas and overlaps said common electrode lines in said outer periphery of said pixels.

[Claim 2] The active matrix liquid crystal display device as defined in claim 1, wherein said signal lines overlap said common electrode lines in said outer periphery of said pixels, and said light shield layer is formed only outside said pixel areas and overlaps said common electrode lines in said outer periphery of said pixel areas.

[Claim 3] The active matrix liquid crystal display device as defined in claim 1 or 2, wherein said light shield layer is applied with a potential equal to a potential applied to said common electrode.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to LCD device and, more particularly, to an active matrix LCD device wherein liquid crystal is driven by an electric field acting in the direction substantially parallel to the substrates.

[0002]

[Prior Art]

LCD devices are generally categorized into to types including a passive matrix LCD device and an active matrix

LCD device based on the driving system therefor. The active matrix LCD device includes an drive element such as transistor or diode in each pixel element, for charging a capacitor thereof with a signal voltage while selecting the pixel element for an on-state in a time-division scheme and allowing capacitor to hold the signal voltage during a subsequent off-period, thereby displaying an image. Compared to the passive matrix LCD device wherein the signal voltage is applied to the liquid crystal by using a time-division matrix-drive scheme, the active matrix LCD features a higher contrast and a larger-capacity display.

[0003]

A twisted-nematic mode (referred to as TN mode, hereinafter) has been generally used as the operational mode of the liquid crystalin the active matrix LCD device, wherein the aligned direction (referred to as director, hereinafter) of the longer axes of the liquid crystalmolecules is twisted by about 90 degrees between the upper and lower substrates, using an electric field in the direction perpendicular to the substrates for rotating the director in the vertical direction.

[0004]

However, the TN mode generally has a defect wherein the view angle is narrow. Accordingly, along with development for a larger-capacity display to enlarge the display area, there arises a discrepancy in the image between the center and periphery of the display screen as viewed from a viewing spot in an oblique

direction, whereby it is impossible to achieve a correct display.

[0005]

For solving the above problem, an in-plane switching mode (referred to as IPS mode, hereinafter) has been developed for generating an electric field in the direction parallel to the substrates for rotating the director within the horizontal plane. In the LCD device wherein the liquid crystal is driven by an electric field parallel to the substrates, the horizontal alignment of the orientation affords an advantage in that the double refraction characteristic of the liquid crystal is scarcely changed even if the viewpoint is moved, thereby achieving a wider view angle compared to the TN mode LCD device.

[0006]

First conventional LCD device is shown in Figs. 7 to 10. Fig. 7 is a top plan view of the first conventional technique, Fig. 8 is a sectional view taken long line C-C in Fig. 7, Fig. 9 is a sectional view taken along line B-B in Fig. 7, and Fig. 10 is a diagram showing the black matrix potential in the first conventional technique.

[0007]

The first conventional LCD device has a plurality of scanning lines 3, signal lines 4 and common electrode lines, disposed in a matrix on a transparent insulating substrate (referred to as TFT substrate hereinafter) 1, and includes a TFT 6 and a pixel electrode 7 at the intersection between the scanning

line 3 and the signal line 4. The pixel electrode 7 and the common electrode line 5extend parallel to each other as stripe electrodes to generate an electric field 100 having a main component extending substantially perpendicular to both the electrodes.

[0008]

As shown in Fig. 9, another transparent substrate (referred to as counter substrate hereinafter) 2 is disposed in opposed relationship with the TFT substrate 1 with an intervention of a liquid crystal layer 8 to form an active matrix LCD device, the counter substrate 2 mounting thereon a black matrix 9, a color filter 10 and a liquid crystal orientation layer 11.

[0009]

However, in the LCD device using the IPS mode, the electric field generated therein includes unnecessary components between the signal line 4 and adjacent electrodes, which necessitates a light shield. In the first conventional technique, the black matrix 9 formed on the counter substrate 2 shields the space between the signal line 4 and the adjacent electrodes (common electrode line 5). The overlapping arrangement of the TFT substrate 1 and the counter substrate 2 generally involves an alignment error of about 7 to 10 μm. For assuring the effective light shield, the edge of the black matrix 9 should be located with a margin, such as designated by 200 in Fig. 9, from the edge of the common electrode line 5. This causes a larger area of the

black matrix 9 and a smaller opening rate of the pixel area. Patent publication JP-A-9-80415 describes a technique for solving this problem.

[0010]

A second conventional technique is shown in Figs. 11 to 13. Fig. 11 is a top plan view of the second conventional technique (technique described in Patent Publication JP-A-9-70415), Fig. 12 is a sectional view taken along line D-D in Fig. 11, and Fig. 13 is a diagram of the black matrix potential in the second conventional LCD device.

[0011]

The second conventional LCD device (technique described in Patent Publication JP-A-9-80415) includes a plurality of scanning lines 3, signal lines 4 and common electrode lines 5 and has a TFT 6 and a pixel electrode 7 at each intersection between the scanning line 3 and the signal line 4. In addition, as shown in Fig. 12, the LCD device has structures that an insulating film is disposed between the signal lines 4 and the common electrode lines 5, the signal line 4 and the common electrode line 5 have an overlapping portion therebetween, and the black matrix 9 is disposed only in the direction parallel to the scanning lines 3 in the pixel areas.

[0012]

In the structure of the second conventional technique, since the common electrode line 5 overlapping the signal line 4 acts for

the function of light shield, the black matrix for shielding the space between the signal lines 4 and the adjacent electrode need not be provided on the counter substrate 2, whereby a margin for overlapping between the upper and lower substrates and an active matrix LCD device having a larger opening rate can be obtained.

[0013]

However, the first and second conventional LCD devices having a structure wherein the black matrix 9 is formed on the counter substrate 2 involve problems as described hereinafter.

[0014]

In case of the TN mode active matrix LCD device, since the electric field is shielded from the black matrix 9 by the transparent common electrode formed on the substantially entire surface of the counter substrate 2, no electric field affecting the image quality is generated.

[0015]

However, in case of the IPS mode active matrix LCD device, since the black matrix 9 does not have a shield electrode such as the common electrode between the black matrix 9 and the liquid crystal layer 8 in the TN mode, the potential of the black matrix 9 affects the image quality.

[0016]

This will be more specifically described hereinafter. The black matrix 9 is not electrically fixed, and is made of

high-conductive material such as black resist wherein metal or carbon black is dispersed. On the other hand, since the black matrix 9 forms capacitors together with the signal lines 4, scanning lines 3, common electrode lines 5 on the TFT panel side via the insulator such as the liquid crystal layer 8 and the insulator film 14 in the TFT, the potential of the black matrix 9 is determined based on the capacitive coupling acting between each black matrix and the signal lines 4, the scanning lines 3 and the common electrode lines 15.

[0017]

Assuming that the potential of the black matrix 9, the voltages of the signal lines 4, the scanning lines 3, and the common electrode line 5, the coupling capacitances between the black matrix 9 and the signal line 4, between the black matrix 9 and the scanning line 3, between the black matrix 9 and the common electrode line 5 are represented by Vbm, Vd, Vg, Vcom, Cbm-d, Cbm-g, Cbm-com, respectively, the potential Vbm of the black matrix is expressed by equations 1 and 2:

$$Vbm=Vd\times Cbm\text{-}d/Ctotal+Vg\times Cbm\text{-}g/Ctotal +Vcom\times Cbm\text{-}com/Ctotal \text{ - - - - } (1)$$

$$Ctotal=Cbm\text{-}d+Cbm\text{-}g+Cbm\text{-}com \text{ - - - - } (2).$$

[0018]

Voltage Vg of the scanning line 3 is higher than signal voltage Vd of the signal line 4 and the voltage of the pixel electrode 7 during the selected small time interval when the TFT

is turned on by voltage Vg of the scanning line 3, and is lower than voltage Vd and the voltage of the pixel electrode 7 during the remaining time interval.

[0019]

Voltage Vd of the signal line 4 changes at an interval of the horizontal scanning cycle to charge the pixel electrodes selected in succession to a desired voltage. Voltage Vcom of the common electrode line 5 also changes at an interval similar to the interval of voltage Vd or keeps a constant voltage, depending on the drive scheme in the LCD device. Thus, it will be understood from the equations (1) and (2) that the black matrix 9 has a potential different from the potential of the common electrode line s5 and changes at a different interval.

[0020]

The potential of the black matrix 9 deteriorates the image quality based on the reason as follows. In the first and second conventional active matrix LCD devices, a desired electric field 100 having a main component parallel to the substrates and perpendicular to both the electrodes is generated by the potential of the pixel electrode 7 and the potential of the common electrode line 5. In addition, the electric field 100 between the potential of the pixel electrode 7 and the potential of the common electrode line 5 reverses its polarity at a small time interval such as frame interval to prevent a defective image such as burning or stain by preventing localization of impurity ions or charge-up of

the insulator.

[0021]

In the first and second conventional LCD devices shown in Figs. 7 and 11, however, a potential different from the potential of the pixel electrode 7 and the potential of the common electrode 5 resides on the black matrix 9. The potential of the black matrix 9 is different from the potential of the pixel electrode 7 and the potential of the common electrode 5, and changes at a different time interval. This causes that a deleterious stray electric fields 101 and 102 is generated by the black matrix 9 in the pixel area 300, the stray electric field obstructing the electric field to be used for desired display to thereby deteriorate the image quality. In addition, the potential of the black matrix 9, which is different in the magnitude and the timing from the display electric field, causes an effective DC component in the electric field in the display panel, which generates burning or stain on the panel to degrade the image quality.

[0022]

As an example, the results of the simulation for the first conventional technique are shown in Fig. 10. The simulation used an assumption that an image was obtained by a potential difference of 5 volts applied between the pixel electrode 7 and the common electrode 5, provided that 480 scanning lines 3 were disposed in the LCD device with a dot-inversion drive system wherein pixel electrodes in the adjacent pixels had opposite

potential polarities. The calculation was based on the voltages of the respective lines such that the voltage of the scanning lines 3 was 21 volts and –8 volts during an on-state and an off-state thereof, respectively, as shown in Fig. 8, the voltage of the signal lines 4 was 12 volts and 2 volts during a positive voltage frame and a negative voltage frame, respectively, and the voltage of the common electrode line 7 was fixed at 6 volts. When the voltage Vg of the scanning line 3 was off, voltage of the pixel electrode 7 dropped below voltage Vd of the signal line 4 due to the charge in the TFT channel flowing into the pixel electrode 7 and to the change in the coupling capacitance between the scanning line 3 and the pixel electrode 7. The voltage drop was about 1 volt in the simulation, which caused the voltage difference between the pixel electrode 7 and the common electrode 5 to be about 5 volts. The black matrix 9 entirely shielded the signal lines 4 and the scanning lines 3, and had an initial potential of zero volts.

[0023]

As Fig. 10 shows in the results of the simulation, the potential of the black matrix 9 fluctuates around about 3V during the time interval when the pixel maintains voltage in the off state. The electric field generated by the potential of the black matrix 9 leaks to the pixel area due to the arrangement of the black matrix 9 residing in the pixel area.

[0024]

In Fig. 7, the outline of the electric field from the black

matrix 9 is illustrated. In the positive voltage frame, voltage Vcom of the common electrode line 5 is 6 volts, the voltage of the pixel electrode 7 is 11 volts, voltage Vbm of the black matrix 9 is about 3 volts. Thus, a potential difference of 5 volts is generated between the common electrode line 5 and the pixel electrode 7, and generates the desired parallel electric field 100. A potential difference of about 3 volts is also generated between the black matrix 9 and the common electrode line 5 in the vicinity of the black matrix 9 to generate electric field 101. A potential difference of about 8 volts is further generated between the black matrix 9 and the pixel electrode 7 to generate electric field 102.

[0025]

Thus, electric field other than the desired parallel electric field 100 is generated in the vicinity of the black matrix 9 to prevent display of correct image. In a negative voltage frame, a potential difference of 5 volts having a polarity opposite to the polarity in the positive voltage frame is generated between the common electrode line 5 and the pixel electrode 7, to generate the desired parallel electric field 100. In the vicinity of the black matrix 9, however, a potential difference of about 3 volts having a polarity same as that in the positive voltage frame is also generated between the black matrix 9 and the common electrode line 5 to generate electric field 101. The fact that the electric field having the opposite polarities and the same

magnitude is not obtained in the positive voltage frame and in the negative voltage frame means an effective DC voltage being applied.

[0027]

Fig. 13 shows results of simulation in the second conventional technique. The conditions were similar to those in the simulation in the first conventional technique. In the second conventional technique, the substantial absence of a portion of the black matrix 9 overlapping the signal lines 4 causes an extremely smaller capacitance Cbm-d between the black matrix 9 and the signal line 4 expressed in equations (1) and (2) compared to the first conventional technique. Thus, voltage Vbm of the black matrix 9 is scarcely affected by voltage Vd of the signal lines 4. Since voltage Vd of the signal line 4 in root-mean-square value is substantially equal to voltage Vcom of the common electrode line 5, a larger difference is generated between voltage Vbm of the black matrix 9 and voltage Vcom of the common electrode line 5 in the second conventional technique compared to the first conventional technique.

[0028]

Accordingly, electric field 101 generated between the black matrix 9 and the pixel electrode 7 as well as electric field 102 generated between the black matrix 9 and the common electrode line 7 is larger in this case and generates a larger DC component.

[0029]

A larger deleterious electric field is generated in the second conventional technique, compared to the first conventional technique. In addition, there are problems that the deleterious electric field has a large DC component, prevents a correct image display and, in addition, easily generates a defective image such as burning and stain.

[0030]

[Problems to be solved by the Invention]

As described above, in an IPS mode active matrix LCD device, the potential of the black matrix 9 on the counter substrate 2 generates a deleterious electric field in the pixel area to cause a defective image display. In addition, the deleterious electric field includes a DC component and generates a defective image such as burning and stain.

[0031]

The present invention is achieved based on the above problems, and the object thereof is to provide a potential to the black matrix in an IPS-mode active matrix LCD device to provide a high-quality active matrix LCD device which is capable of reducing the potential difference between the potential of the black matrix and the potential of the pixel electrode or the common electrode to suppress the adverse affect on the image display from the potential of the black matrix.

[0032]

[Means for Solving the Problems]

To achieve the above object, the active matrix LCD device of the invention of claim 1 is such that liquid crystal is sandwiched between one and another transparent insulating substrates, said one transparent insulating substrate includes a plurality of scanning lines, signal lines and common electrode lines arranged in a matrix, said scanning lines and said signal lines are driven by a scanning signal driver and a video signal driver, respectively, disposed at a peripheral area, an intersection between said scanning line and said signal line includes a thin film transistor having a gate electrode, a drain electrode, and source electrode connected to said scanning line, said signal line and said pixel electrode, respectively, said one transparent insulating substrate includes a plurality of pixel areas wherein the molecular axis directions of said liquid crystal molecules are rotated by an electric field formed by said pixel electrode and said common electrode line in a plane parallel to said substrate to control transmittance, and said another transparent insulating substrate includes a light shielding layer for shielding at least an area other than said pixel areas, characterized in that:

said common electrode lines are configured to encircle outer periphery of said pixel areas, said pixel electrode overlaps said common electrode lines in the outer periphery of said pixel, said light shielding layer resides outside said pixel areas and overlaps said common electrode lines in said outer periphery of said pixels.

[0033]

In addition, to achieve the above object, the active matrix LCD device of the invention of claim 2 is such that, in the active matrix liquid crystal display device as defined in claim 1, said signal lines overlap said common electrode lines in said outer periphery of said pixels, and said light shield layer is formed only outside said pixel areas and overlaps said common electrode lines in said outer periphery of said pixel areas.

[0034]

Further, to achieve the above object, the active matrix liquid crystal display device of the invention of claim 3 is such that, in the active matrix LCD device as defined in claim 1 or 2, said light shield layer is applied with a potential equal to a potential applied to said common electrode.

[0035]

By the configurations as recited above, the electric field from the black matrix is concentrated onto the common electrode lines which are configured to encircle the periphery of the active area, and does not leak into the pixel area. Thus, the adverse effect on the electric field of the pixel area by the electric field generated from the black matrix is suppressed, whereby an active matrix LCD device having an excellent image display can be obtained.

[0036]

[Embodiments of the Invention]

Now, the present invention is described with reference to drawings.

[0037]

(First Embodiment)

Figs. 1 to 3 show a first embodiment of the present invention. Fig. 1 is a top plan view of the first embodiment of the present invention, Fig. 2 is a sectional view taken along line A-A in Fig. 1, and Fig. 3 is a diagram of the black matrix potential in the first embodiment of the present invention.

[0038]

On a TFT substrate 1, there are provided scanning lines 3, signal lines 4, TFT areas 6, pixel electrodes 7 having an overlapping portion overlapping common electrode lines, and common electrode lines 5 configured to encircle the pixel areas. On a counter substrate 2, there are provided a black matrix 9 disposed outside the pixel area in the vicinity of the signal lines and in the vicinity of the scanning lines and having an overlapping portion overlapping the common electrode lines 5 formed in the outer periphery of the pixel, a color filter 10 for displaying color image, and an overcoat layer 12. Between both the substrates, there is provided a liquid crystal orientation layer 11 and a liquid crystal layer 8.

[0039]

Now, fabrication method is described hereinafter. The scanning lines 3 and the common electrode lines 5 both made of

chrome are first formed on the TFT substrate 11. A gate insulator film 14 made of silicon oxide, an a-Si layer and a n+type a-Si layer are then formed so as to cover the scanning lines 3. Then, the signal lines 4 and the pixel electrodes 7 are formed. The common electrodes 7 and the common electrode lines 5 are disposed to extend parallel to each other so as to form stripe electrodes, as shown in Fig. 1, which can generate an electric field 100 having a main component extending parallel to the substrates and perpendicular to the both electrodes 7 and 5.

[0040]

The pixel electrode is formed as a stripe extending perpendicular to the scanning lines 3; however, it is sufficient that the pixel electrode 7 generates an electric field parallel to the substrates and encircles the pixel area defined by the common electrode lines 5, and especially, the shapes and directions of the electrodes need not be same as those shown in Fig. 1. Although the scanning lines 3, signal lines 4, common electrodes 5 and the pixel electrodes 7 are all made of chrome, these may be made of other materials having a lower electric resistance, such as aluminum and molybdenum. Over the chrome layer, a passivation film 17 is deposited by CVD of silicon nitride for protecting the TFTs.

[0041]

Another chrome film is formed on the counter substrate 2, followed by patterning thereof to form the black matrix 9 so that

the black matrix 9 does not reside in the light transmitting area. Subsequently, three-time photolithographic etching process is conducted to pattern the materials wherein R-G-B pigments are dispersed in polyimide-based photosensitive polymer, thereby forming a color filter 10. Thereafter, the overcoat layer 12 is formed by spin-coating and subsequent heating of polyimide. The overcoat layer 12 prevents impurities eluted from the color filter from being mixed into the liquid crystal layer. The overcoat layer 12 also functions for flattening the surface of the counter substrate 2, controlling the thickness of the liquid crystal layer 18 with excellent in-plane uniformity, and suppressing disclination, so as to obtain an excellent image quality.

[0042]

The orientation layers 21 made of polyimide are then formed on the resultant TFT substrate 11 and the counter substrate 2. After the rubbing process of both the orientation layers 11, polymer beads having a diameter corresponding to the gap between the substrates are scattered, followed by bonding the substrates 1 and 2 in opposed relationship, with the nematic liquid crystal layer 18 injected therebetween. A pair of polarizing plates are then disposed for sandwiching therebetween the substrates, with the polarizing axis of one of the polarizing plates being aligned with the orientation of the liquid crystal and with the polarizing axis of the other of the polarizing plates being normal to the orientation.

[0043]

Fig. 3 shows results of simulation for the first embodiment, wherein it is assumed that 480 scanning lines 3 are provided in the LCD device driven by a dot-inversion drive system wherein polarities are reversed between adjacent pixels, and a potential difference between the pixel electrode 7 and the common electrode line 5 is 5 volts. As shown in Fig. 3, each voltage of the electrodes is calculated for the case that the potential of the scanning line 3 is 21 volts in an on-state and -8 volts in an off-state thereof, the potential of the signal line 4 is 12 volts in a positive voltage frame and 2 volts in a negative voltage frame, and the potential of the common electrode line 7 is fixed at 6 volts. When the voltage of the scanning line 3 is turned off, the charge in the TFT channel flows into the pixel electrode 7, and the voltage of the pixel electrode 7 fluctuates due to the charge as well as the coupling capacitance between the scanning lines 8 and the pixel electrode 7, which cause a voltage fall of the pixel electrode. The voltage fall causes the voltage of the pixel electrode to be about 1 volt lower than voltage of the signal line 4, which results in a voltage difference of about 5 volts between the voltage of the pixel electrode 7 and voltage of the common electrode line 5.

[0044]

The potential of the black matrix 9, as shown in Fig. 3, is similar to that in the first conventional technique. However, in

the structure of the present embodiment, the electric field 101 from the black matrix 9 is substantially entirely directed toward the adjacent common electrode line 5 and does not leak into the pixel area.

[0045]

As a result, compared to the first conventional active matrix LCD device having therein a black matrix, the present embodiment suppresses the electric field from the black matrix 9 to generate deleterious electric field, causes a defect such as burning and stain due to the no DC voltage applied to the pixel area, and provides an active matrix LCD device having excellent image quality.

[0046]

(Second Embodiment)

Figs. 4 and 5 show a second embodiment of the present invention. Fig. 4 is a top plan view of the second embodiment, and Fig. 5 is a diagram of the black matrix potential in the second embodiment of the present invention.

[0047]

On a TFT substrate 1, there are provided scanning lines 3, signal lines 4, TFT areas 6, pixel electrodes 7 having an overlapping portion overlapping common electrode lines, and common electrode lines 5 configured to encircle the pixel areas. An insulator film is disposed between the signal lines 4 and the common electrode lines 5, and the signal lines 4 and the common

electrode lines 5 have an overlapping portion therebetween.

[0048]

On a counter substrate 2, there are provided a black matrix 9 disposed to shield the area other than the pixel area, having an overlapping portion overlapping the common electrode lines 5, and formed not to reside in the pixel area, a color filter 10 for displaying color image, and an overcoat layer 12. Between both the substrates 1 and 2, there is provided a liquid crystal orientation layer 11 and a liquid crystal layer 8.

[0049]

The method for manufacturing the second embodiment of the present invention is similar to the first embodiment of the present invention as described above. Fig. 5 shows results of simulation for the first embodiment, wherein the conditions are similar to those in the first embodiment. In the second embodiment, since the black matrix does not substantially reside on the signal lines, similarly to the second conventional technique, the capacitance Cbm-d between the black matrix 9 and the signal lines 4 defined in equations (1) and (2) is extremely small. As a result, the voltage Vbm of the black matrix is less affected by the voltage Vb of the signal lines 4. Since the voltage Vd of the signal lines 4 in the root-mean-square value is near the voltage Vcom of the common electrode lines 5, the difference between the voltage Vbm of the black matrix 9 and the voltage Vcom of the common electrode lines 5 is larger

in the second embodiment compared to the first embodiment.

[0050]

However, as shown in Fig. 4, the electric field from the black matrix 9 is an electric field 101 substantially all of which is directed to the adjacent electrode and does not leak into the pixel area. As a result, the present embodiment generates a less deleterious electric field from the black matrix potential to the pixel areas, generates less defective image such as burning and stain due to absence of the DC voltage being applied to the pixel area, and achieves excellent image display. In addition, since the common electrode lines 5 overlapping the signal lines 4 has a shield function, the black matrix 9 for shielding the space between the signal lines and the adjacent electrodes need not be disposed on the counter substrate 2. Accordingly, a margin for overlapping both the upper and lower substrates is not needed, whereby the present embodiment achieves an active matrix LCD device having a higher effective opening rate.

[0051]

(Third Embodiment)

Fig. 6 shows a third embodiment of the present invention. Fig. 6 is a top plan view of the third embodiment of the present invention, and shows the structure of the peripheral area of the panel. The unit pixel of the third embodiment is similar to that of the first embodiment shown in Fig. 1.

[0052]

As shown in Fig. 6, in the third embodiment, the potential of the common electrode lines 5 on the TFT substrate 1 is communicated with the black matrix 9 on the counter substrate 2 via a metallic layer same as the signal lines at a transfer section 20 in the peripheral area of the panel. Several transfer sections similar to the transfer section 20 are provided in the peripheral areas of the panel, whereby this structure provides the configuration wherein the whole area of the black matrix 9 is applied with a potential same as the potential of the common electrode lines 5.

[0053]

The method for manufacturing the third embodiment of the present invention is similar to that of the first embodiment recited before. As shown in Fig. 6, a through-hole 21 between the common electrode line 5 and the signal line is formed by etching the gate insulation film 14, the passivation film 17 is etched in the transfer section 20, and metallic signal lines are formed on the surface of the substrate so as to be exposed. The counter substrate 2 is fabricated such that the overcoat layer 12 does not cover the transfer section 20, and the black matrix 9 is not exposed on the surface of the counter substrate 2.

[0054]

A liquid crystal orientation film 11 is formed on each of the TFT substrate 1 and the counter substrate 2 so as not to cover the transfer section 20. After both the substrates are subjected to a

rubbing process, polymer beads having a diameter corresponding to the gap size are scattered on the entire surface, silver paste is dropped onto the transfer section 20 disposed in the peripheral area of the panel so as to obtain continuity between the substrates 1 and 2, both the substrates are bonded together so as to oppose both the liquid crystal orientation layers 11, and nematic liquid crystal is injected between the substrates. Both the substrates 1 and 2 are then sandwiched between and bonded to a pair of polarizing plates so that the polarizing axis of one of the polarizing plates resides in the direction same as the direction of the liquid crystal orientation layer and the polarizing axis of the other of the polarizing plates resides normal to the direction of the liquid crystal orientation layer. The other process is similar to that in the first embodiment.

[0055]

In the third embodiment of the present invention, since the potential is same between the common electrode line 9 and the common electrode line 5, no electric field is generated between the black matrix 9 and the common electrode line 5. The overlapping portion between the black matrix 9 and the common electrode line 5 resides in the very vicinity of the pixel area, thus if a DC electric field is generated for a long period of time in this portion to cause localization of impurity ions or charge-up of the insulator, it affects the pixel area for a long time operation to cause a defective image display such as burning and stain.

[0056]

In addition, in the third embodiment of the present invention, since no DC electric field is generated between the black matrix 9 and the common electrode line 5, possibility of localization of the impurity ions and the charge-up of the insulator is reduced, and long time reliability can be obtained against the defective image display such as burning and stain.

[0057]

Thus, an active matrix LCD device can be obtained which has a long time reliability against the defective image display such as burning and stain because it is less susceptible to deleterious electric field from the black matrix to the pixel area, generates less defective image display such as burning and stain because no DC voltage is applied between the pixel area to thereby achieve superior image display, compared to the conventional active matrix LCD device, and in addition, it generates no DC electric field in the overlapping portion between the black matrix 9 and the common electrode line 5 residing in the very vicinity of the pixel area whereby possibility of the localization the impurity ions and charge-up of the insulator is reduced in the overlapping portion.

[0058]

[Effects of the Invention]

As described above, according to the active matrix LCD device of the present invention, an active matrix LCD device can

be manufactured which operates with an electric field parallel to the substrates and is capable of suppressing the adverse affects by the electric field generated from the black matrix to thereby achieve a superior image display.

[0059]

In addition, since the black matrix for shielding light in the space between the signal lines and the adjacent electrodes is not need on the counter substrate, and thus a margin for overlapping both the substrates is not needed, a higher effective opening rate can be especially achieved in the active matrix LCD device.

[0060]

Further, by applying the common electrode potential to the active matrix, a DC electric field can be reduced in the vicinity of the pixel areas, whereby localization of impurity ions and charge-up of the insulator can be suppressed to achieve a long time reliability against the defective image display such as burning and stain.

[BRIEF DESCRIPTION OF DRAWINGS]

[Fig. 1]

A top plan view of a first embodiment of the present invention.

[Fig. 2]

A sectional view taken along line A-A in Fig. 2.

[Fig. 3]

A diagram of the black matrix potential in the first

embodiment of the present invention.

[Fig. 4]

A plan view of a second embodiment of the present invention.

[Fig. 5]

A diagram of the black matrix potential in the second embodiment of the present invention.

[Fig. 6]

A top plan view of the third embodiment of the present invention.

[Fig. 7]

A top plan view of an active matrix LCD device as a first conventional example.

[Fig. 8]

A sectional view taken along line C-C in Fig. 7.

[Fig. 9]

A sectional view taken along line B-B in Fig. 7.

[Fig. 10]

A diagram of the black matrix potential in the first conventional example.

[Fig. 11]

A top plan view of an active matrix LCD device as a second conventional example.

[Fig. 12]

A sectional view taken along line D-D in Fig. 11.

[Fig. 13]

A diagram of the black matrix potential in the second conventional example.

[Description of Signs]

1 TFT substrate

2 counter substrate

3 scanning line

4 signal line

5 common electrode line

6 TFT

7 pixel electrode

8 LC layer

9 black matrix

10 color filter

11 LC orientation layer

12 overcoat layer

14 gate insulation film

17 passivation layer

20 transfer section

21 common electrode line-signal line metallic through-hole

100 parallel electric field

101 black matrix-common electrode line electric field

102 black matrix-pixel electrode electric field

[Document Name] Abstract

[Abstract]

[Object] To provide a high-quality active matrix LCD device by providing a potential to a black matrix to reduce the potential difference between the black matrix potential and the pixel electrode potential as well as the common electrode potential and to suppress the adverse affects on the image display by the black matrix.

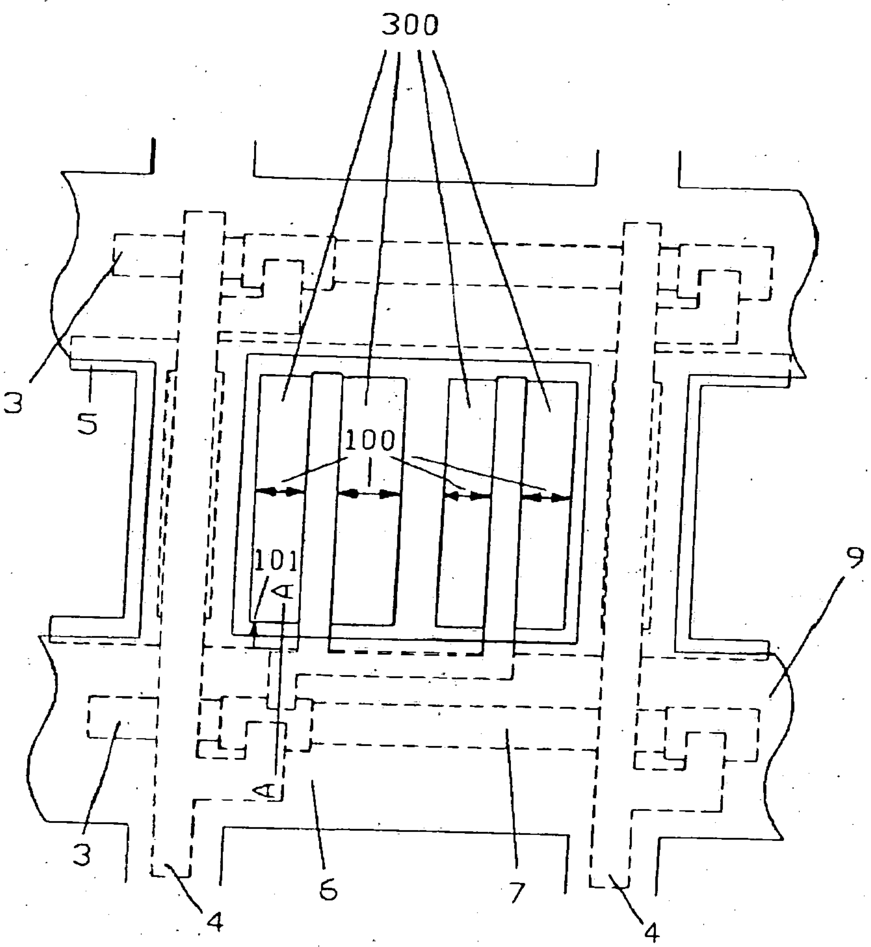
[Means for Solving the Problem]

In an active matrix LCD device, common electrode lines 5 are configured to encircle the outer periphery of the pixel area, pixel electrode 7 overlaps with common electrode lines 7 in the outer periphery, shield layer resides outside the pixel areas, and the outer periphery of the pixel overlaps with the common electrode lines 5.

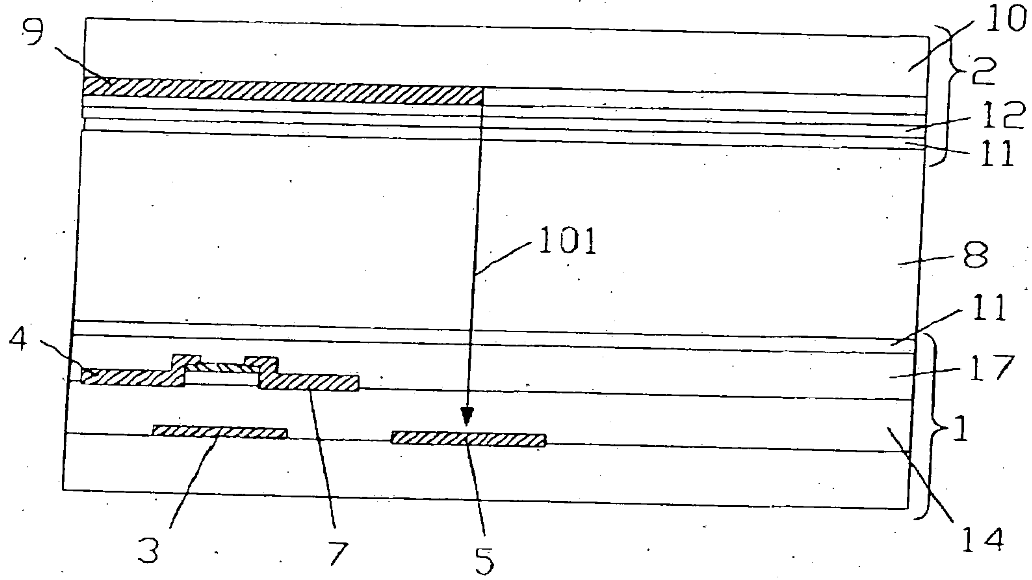
[Selected Drawing] Fig. 1

[Document Name] Drawings

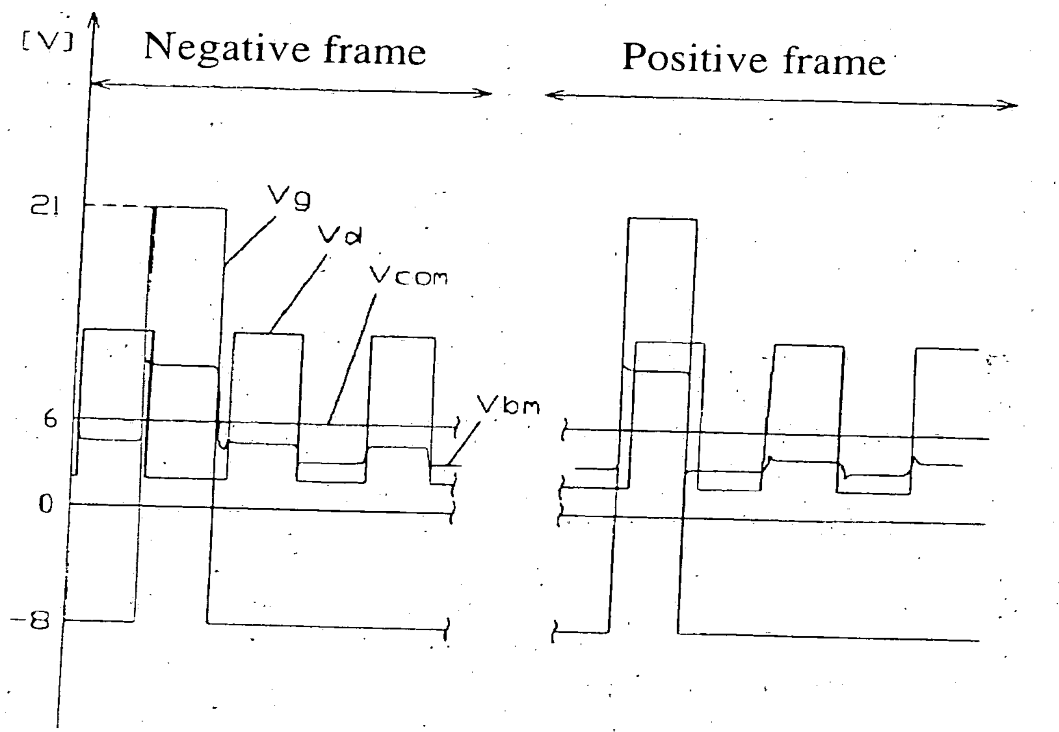
[Fig. 1]



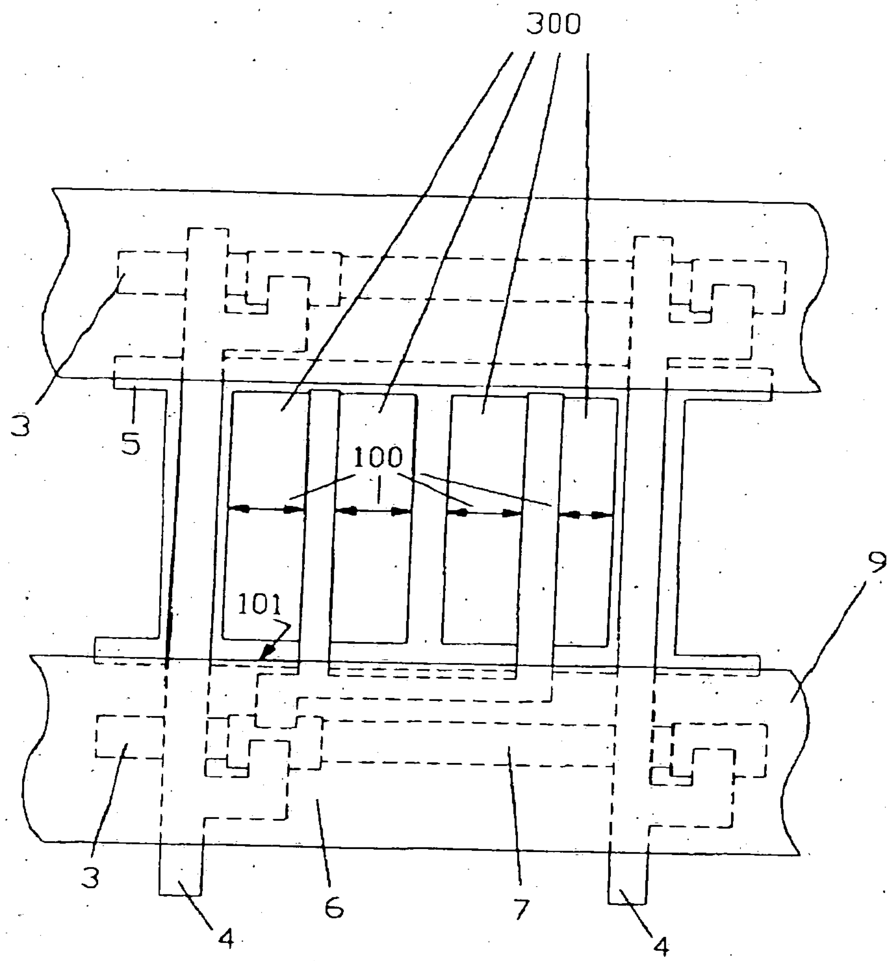
[Fig. 2]



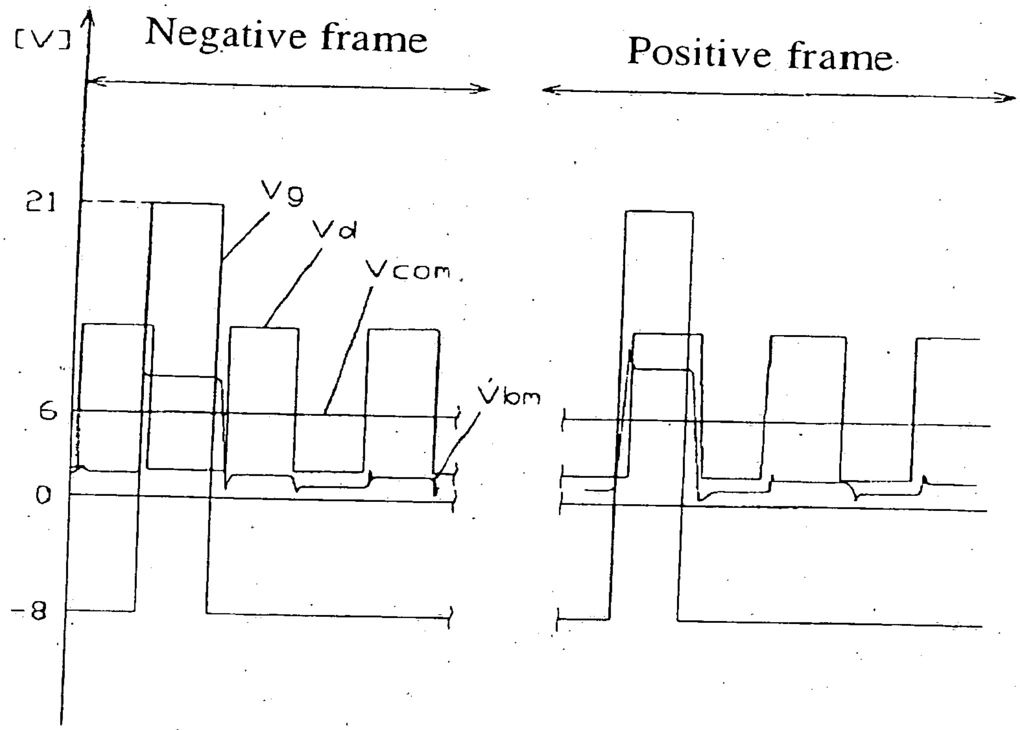
[Fig. 3]



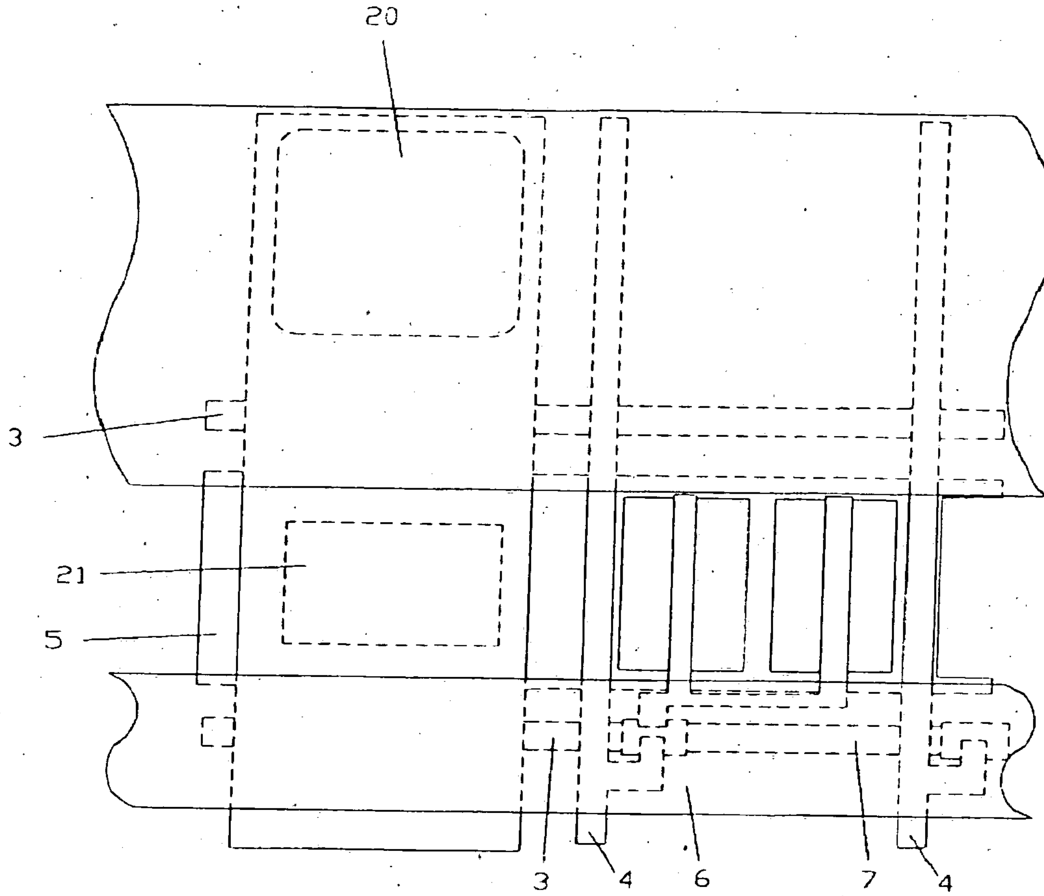
[Fig. 4]



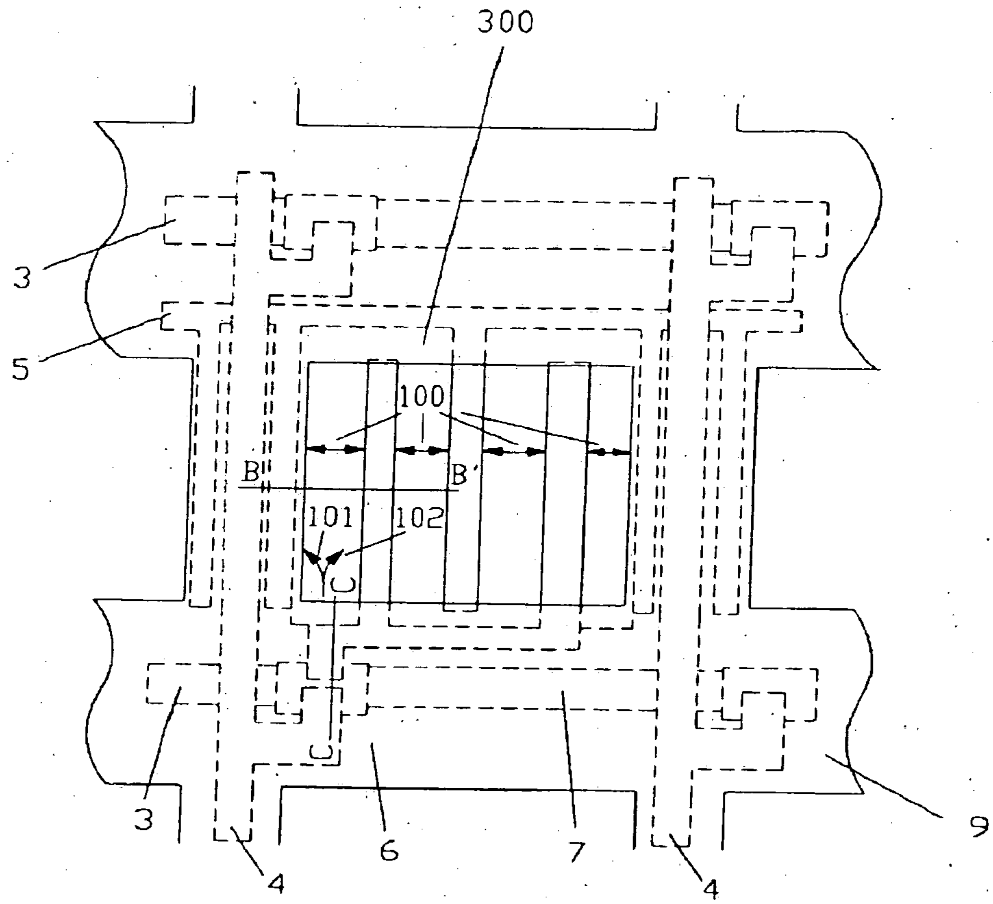
[Fig. 5]



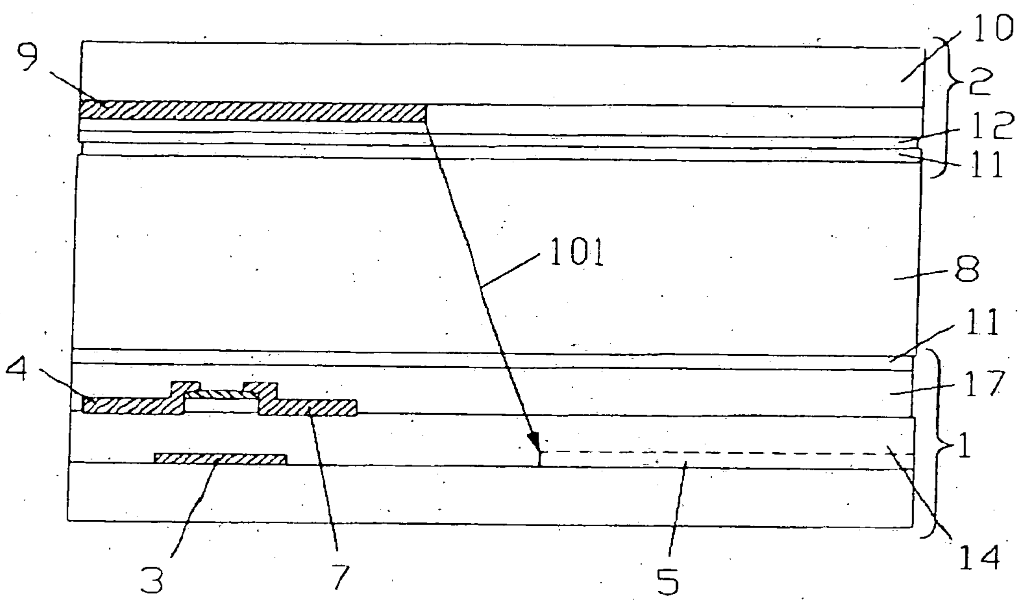
[Fig. 6]



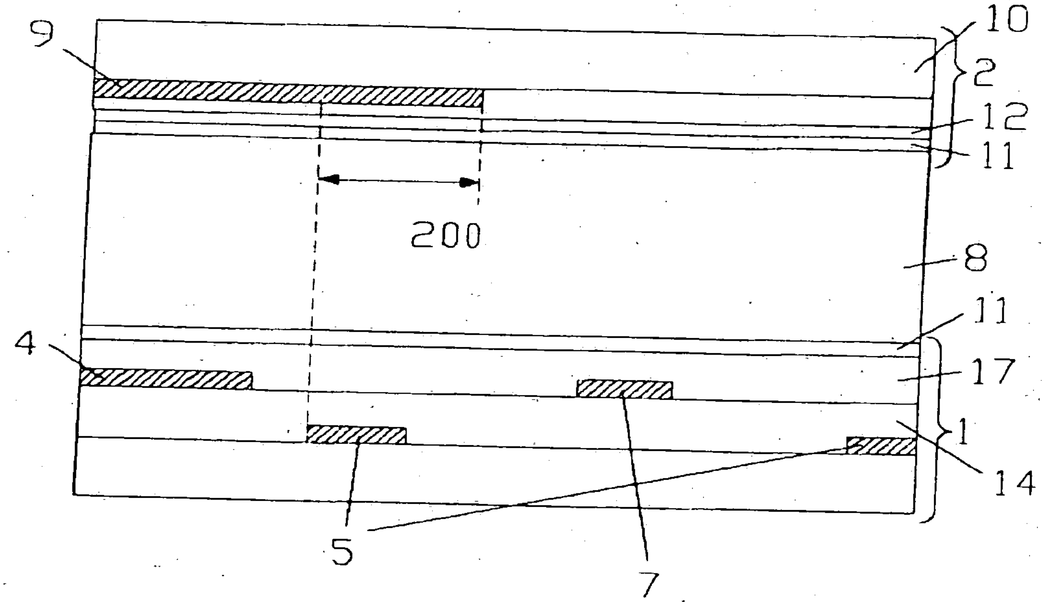
[Fig. 7]



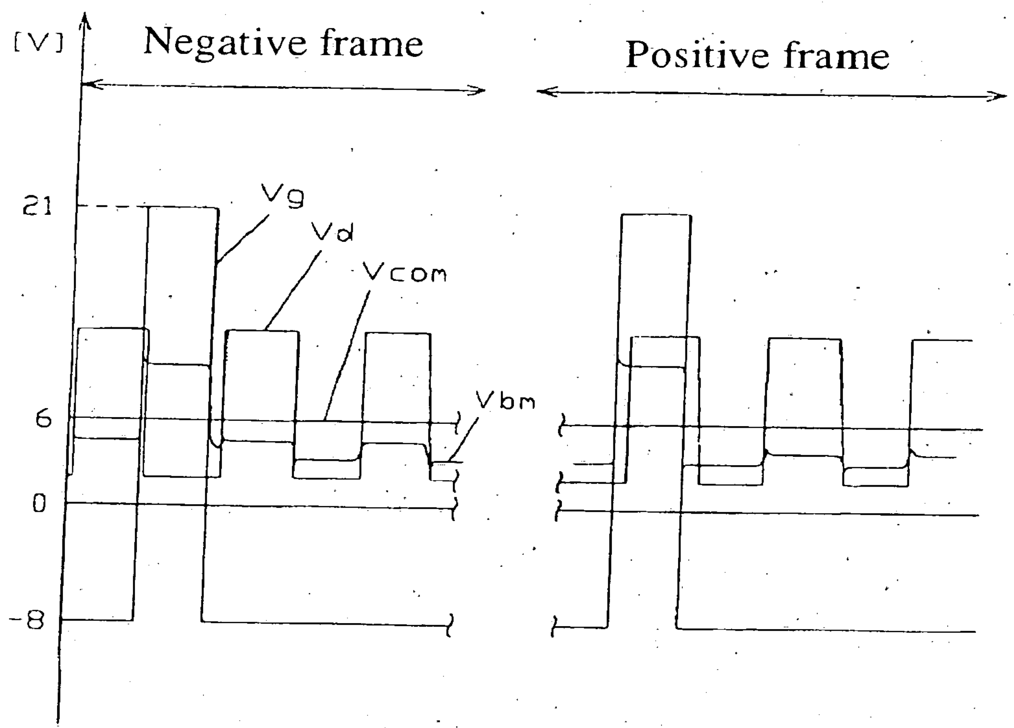
[Fig. 8]



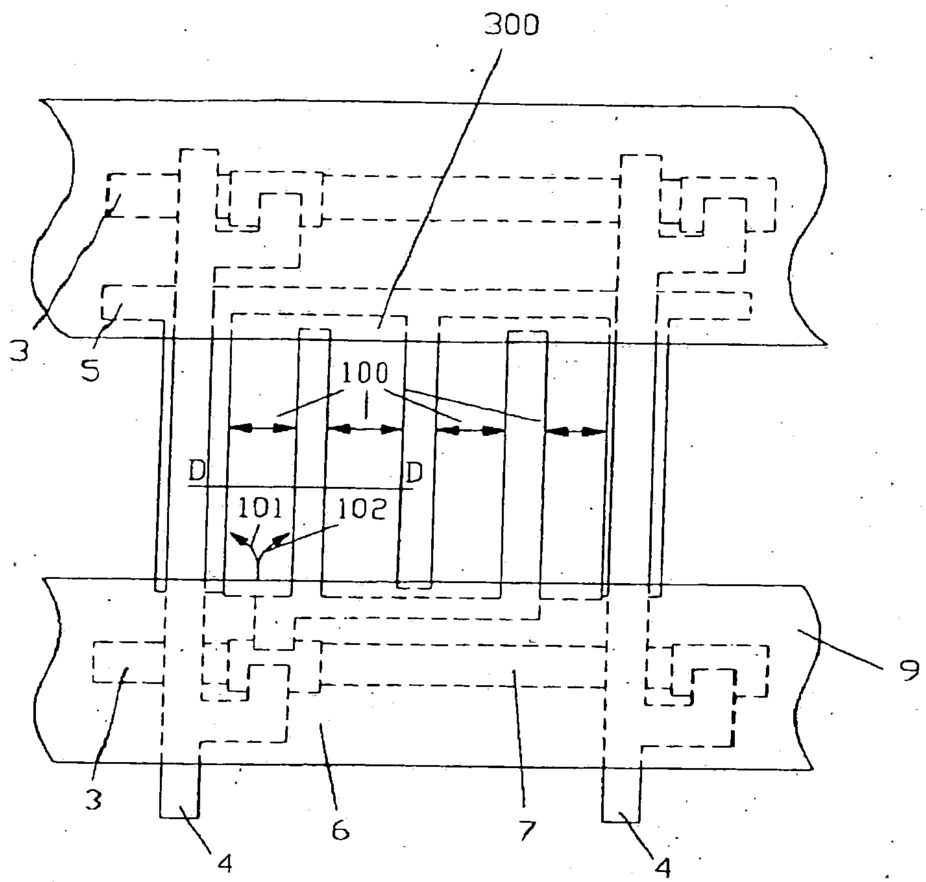
[Fig. 9]



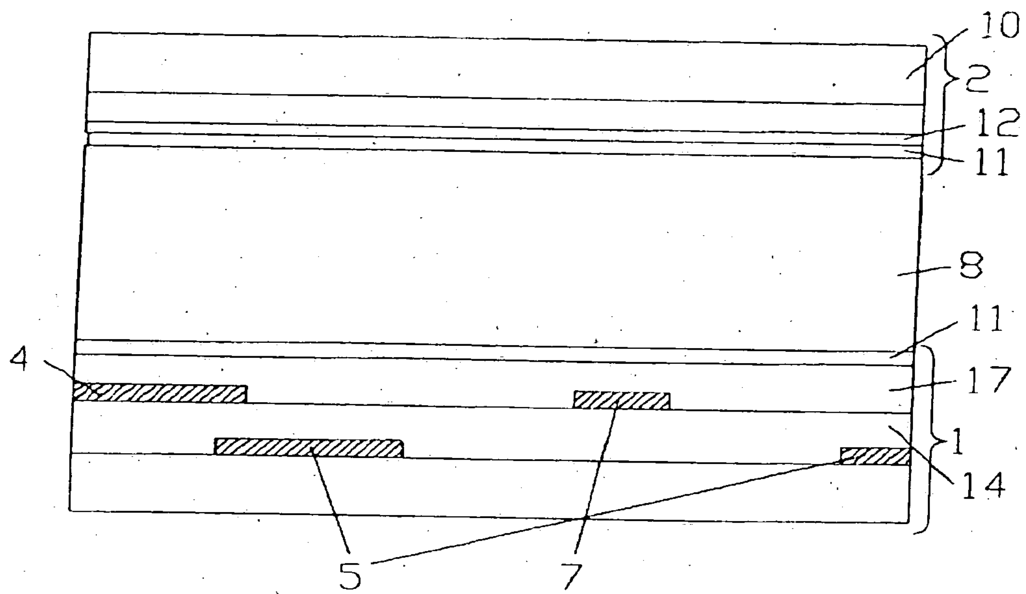
[Fig. 10]



[Fig. 11]



[Fig. 12]



[Fig. 13]